White Paper

Glass Basics

March 2022

Australian Glass Group®

Glass Basics

Glass is an amazing product that we use in our buildings in various applications. It can be transparent, opaque, tinted, coloured, reflective, strong, safe and coated for enhanced performance. Where would we be without glass? For windows and glass doors it allows us to live and work in buildings with a view and natural light filling our spaces while being solid and protecting us from the outside elements.

It is important to note that when we state 'Glazing' we are not talking about the Glass alone. Glazing is the Glass + Frame + Sealants + Hardware as well as any Screens (if used).

The supply chain of glass can be simplified by starting 'Upstream' with the raw material glass manufacturer (a Float Plant) and as it travels 'Downstream' it gets value added to it at each step; first by a Glass Processor and then by a Window Fabricator until the final product is used
(windows and glass doors).

Float Plant

When we start with regular glass used in buildings, we are using Soda-Lime-Silicate glass which is manufactured by a 'Float Plant'. There are several names for this glass: Clear Glass, Float Glass, Clear Float Glass, Float, Annealed Glass. It is made up of raw ingredients including:

- Silica Sand
- Soda Ash (Sodium Carbonate)
- Dolomite
- Limestone
- Salt Cake (Sodium Sulphate)
- Cullet (broken glass)

These ingredients are furnaced and mixed in around 1,600 degrees Celsius, refined and then pulled across a bed of molten Tin at a lower temperature of around 1,100 degrees Celsius. It is here where Physics see the material 'float' across the tin as it is pulled across it, making it flat. The red hot material is then cooled via the annealing process of blowing colder air onto it, putting enough stress in the glass to make it what we know as regular annealed/float glass.

A float plant line can manufacture:

- Clear Glass
- Tinted Glass (eg. Grey, Green, Bronze)
- Low Iron Glass

We call these the 'raw material'. A float plant can also add more value before it is annealed by adding a rolled pattern (similar to a pasta maker) or spraying on a Hardcoat LowE coating.

Glass Processor

A Glass Processer, like Australian Glass Group, takes these raw materials and adds further value by processing the glass. A Glass Processor can:

- Cut and shape the glass
- Arris the edges so they are safe to touch
- Polish the edges so they are smooth to touch
- Make cut outs in the glass
- Edge delete the perimeter for some LowE coatings
- Heat Treat the glass in a furnace - up to 700 degrees Celsius
- Laminate two panes of glass with an interlayer to make Grade A Safety Lam
- Encapsulate at least two panes of glass into an Insulated Glass Unit (IGU)

Window Fabricator

A Window Fabricator then completes the added value by fabricating the processed glass units into full windows and doors using a frame system, seals and installation. The main frame material fabricators can use include:

- Aluminium
- Thermally Broken Aluminium
- Steel
- Timber
- uPVC
- Composites, using a combination of the above material types

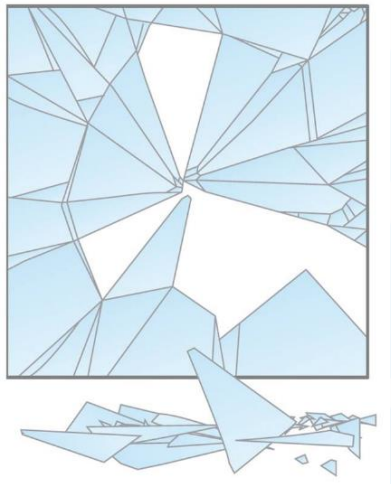
Processing Factors of Glass

A Glass Processor will process glass based on the needs and applications of the glass. Four key needs include:

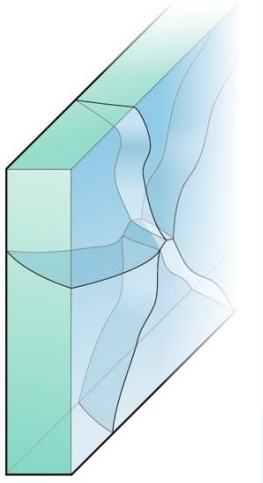
- For where additional Strength is required
- To minimise the risk of Spontaneous Combustion
- To minimise the risk of Thermal Stress
- For when Grade A Safety is required

Strength

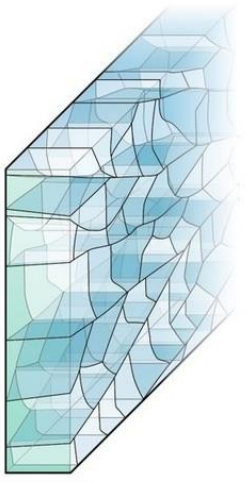
Additional strength may be required in glass due to sizes of units, wind loads and human impact factors. Regular annealed float glass can be heat treated for this by either Heat Strengthening (HS) or fully Toughening (TGH), which is also known as Tempering. If you line up the three types of glass types as per the images below, you may be able to break the Annealed Float glass by throwing a stone with minor strength and if it breaks, it will break as very sharp and dangerous shards of glass. The Heat Strengthened glass can be 2x stronger and so now that stone may need a lot of force behind it to break, and if it breaks it will break into larger pieces that are not as sharp but still dangerous. The Toughened unit can be up to 5x stronger that the Annealed glass as may require a brick thrown at a lot of force to break it, and if it breaks is shatters into thousands of small, unsharp, safer pieces of glass.



Annealed Float



Heat Strengthened



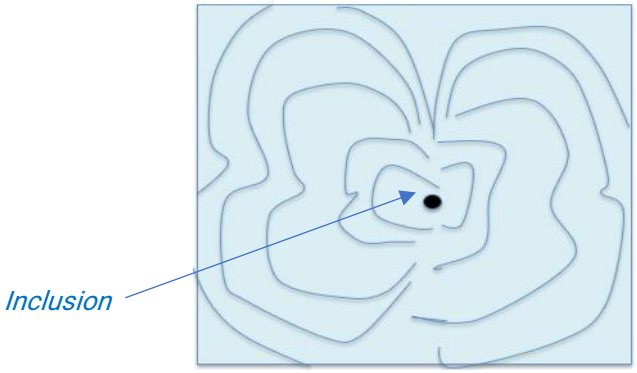
Toughened

Spontaneous Combustion

Spontaneous Combustion is the explosion of Toughened glass due to an unwanted inclusion, like Nickel Sulfide. These inclusions can exist in the glass from its original raw materials (eg. sand) and gets primed/enlarged during the Toughening process. This can result in the Toughened glass exploding at any future point in time, even years.

If the glass remains intact (seen in Toughened laminate) you will see a noticeable 'butterfly' pattern of the break style that centres around the inclusion that can be seen as a dark dot with the naked eye *(see image below).*

To minimise the risk of Spontaneous Combustion you can avoid the use of Toughened glass and use Heat Strengthened if possible, or, if Toughened is required, Heat Soak test on the Toughened glass.



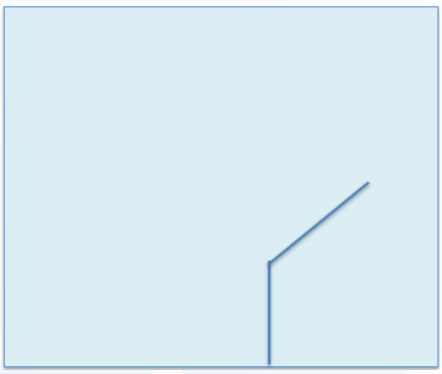
Spontaneous Combustion break pattern

Thermal Stress

Thermal Stress is where annealed glass can crack in any future time period due to extreme temperature stress contrasts in the same piece of glass. Most commonly seen after a cold night and then strong morning sun heating up only part of the glass while the other part remains cold due to shadowing (eg. a tree or building blocking the sun heat reaching part of the glass). The risk is seen most in high solar-heat absorbing glass – eg. grey tint tinted laminated and some dark/tinted coatings.

If the glass remains intact you will see a noticeable pattern of the break style that starts at one edge and then runs off to a 45 degree angle (*see image below*).

To minimise the risk of Thermal Stress breakage you can strengthen the glass by either Heat Strengthening or Toughening.



Thermal Stress break pattern

For more informationon see our White Paper - **Heat Treatment of Glass** on our website.

Grade A Safety Glass

Certified Grade A Safety glass in line with **AS2208:** Safety glazing materials in buildings, is ether Toughened glass or a Laminated glass. The Laminate can be with either annealed glass, heat strengthened glass or toughened glass. This includes standard laminates, white translucent laminate, structural glass like **SkyGlass®** & **SkyGlass Ultra®**, security glass like **IntrudaShield®** & **IntrudaShield Ultra®** and acoustic glass like **Audioshield®**.

Performance Data

There are two key performance factors that the National Construction Code (NCC) dictate for every new building type for its Total System glazing (glass + frame + sealants). These are:

- $U\text{-Value}_w$
- Solar Heat Gain Coefficient ($SHGC_w$)

U-Value

The 'U' is the thermodynamic symbol for Internal Energy.
Think of this as a measure of Insulation - how much heat escapes through the glass per m2 when it is colder outside than inside, as heat wants to move from where it is hot to where it is not.

The bigger the temperature difference between outside and inside and the bigger the glass m2, the more heat will escape.

This also measures non-sun heat from outside that enters in. This occurs at night after a long hot day as materials like the roads, footpaths, bricks and stone absorb the heat and when the sun goes down, this heat re-radiates and wants to enter your building (where it goes from hot to not).

The lower the U-Value, the better the Insulation.

Note - there is glass-only U-Value (Ug) and there is Total System U-Value ($U\text{-Value}_w$) = glass + frame + sealants. The NCC codes dictate Total System $U\text{-Value}_w$.

For Total System performance $U\text{-Value}_w$ see our **Estimated Total System Performance Data** document, or our **Speckel Glazing System Calculator**, or our **Window Energy Rating Scheme (WERS)** section on our website.

SHGC

Solar Heat Gain Coefficient. This is a measure of Solar Control - how much heat from the sun enters inside the building through the glass.

You can think of this as a % so an SHGC of 0.84 is 84% of heat from the sun enters inside (therefore 16% is blocked) while an SHGC of 0.27 is 27% of heat from the sun enters inside (therefore 73% is blocked).

The lower the SHGC, the more passive heat from the sun is blocked from coming inside.

The higher the SHGC, the more passive heat from the sun enters inside your building (which is desirable in colder climates).

Note - there is glass-only SHGC and there is Total System SHGC ($SHGC_w$) = glass + frame + sealants. The NCC codes dictate Total System $SHGC_w$.

For Total System performance $SHGC_w$ see our **Estimated Total System Performance Data** document, or our **Speckel Glazing System Calculator**, or our **Window Energy Rating Scheme (WERS)** section on our website.

Other Factors

There are other performance factors to be aware of also. These include:

- Colour
- Visible Light Transmittance (VLT)
- Visible Light Reflections (VLR-Out & VLR-In)
- Ultraviolet Blockage (UV-Block)
- Selectivity (Light to Solar Gain ratio of VLT divided by SHGC)
- Acoustics (Rw)
- Weight (Kg per m2)

You can find all of these values for our main glass products in our **AGG Performance Data – Glass Only Values** document on our website.

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